Ch:03

Emergence of IoT:

- IoT Growth- A statistical View,
- Application area of IoT,
- Characteristics of IoT,
- Things in IoT, IoT stack,
- Enabling Technologies, IoT challenges,
- IoT levels,
- Cyber physical systems versus IoT,
- Wireless sensor Network with IoT

- IoT is a collection/group of many technologies/devices.
- The simplest of sensors, embedded systems (i.e., the boards), data analytics, mobile and mobile Internet, security aspects and protocols involving cloud storage (computing) have all become enabling technologies.
- In general, enabling technologies/devices fall under one of the following categories:
- 1. Technologies that help in acquiring/sensing data.
- 2. Technologies that help in analysing/processing data.
- 3. Technologies that help in taking control action.
- 4. Technologies that help in enhancing security/privacy.

1.1 Sensors

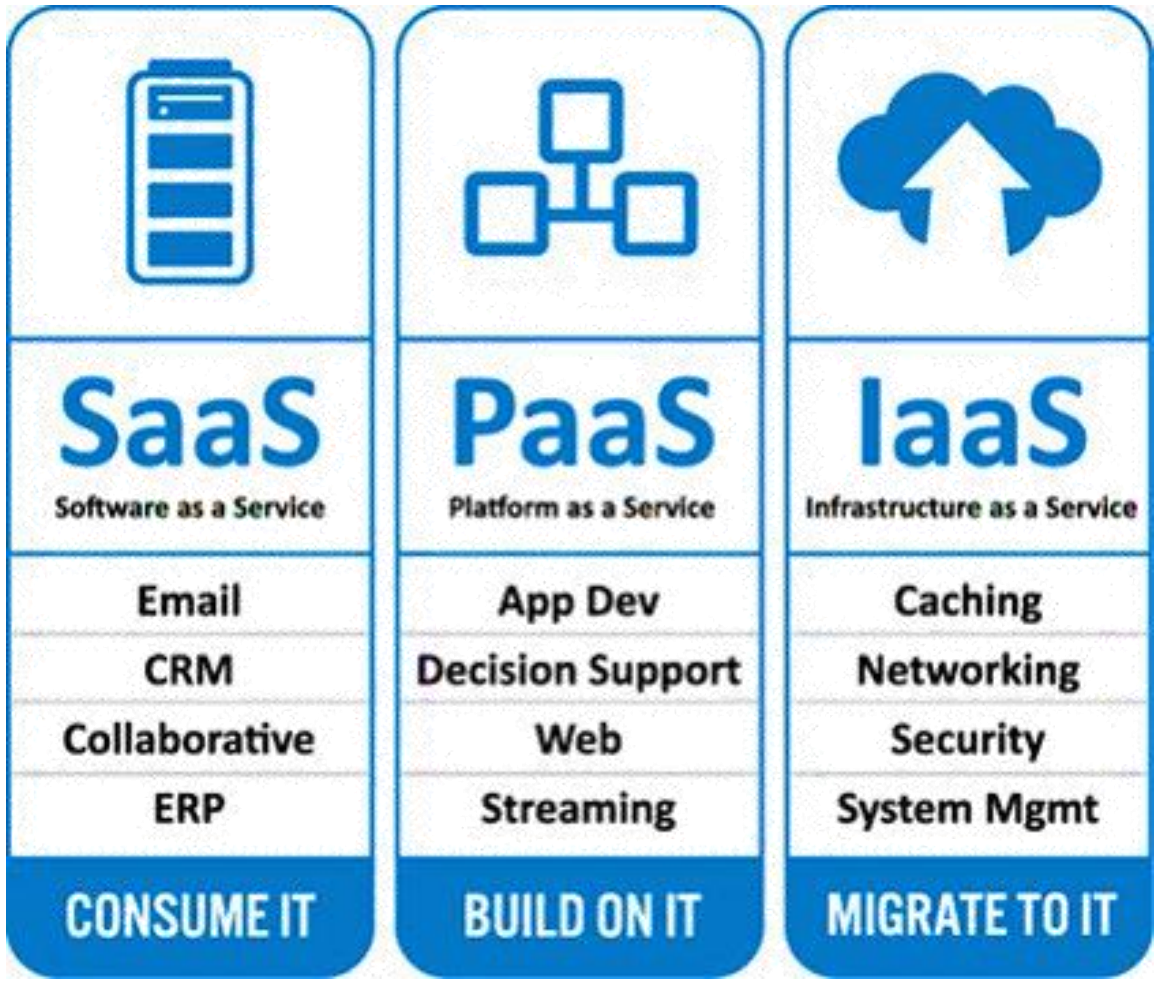
- Sensors are at the heart of any IoT application.
- They sense the environment and retrieve data.
- Sensors are the starting point of any IoT application.
- An example of a sensor is a simple temperature monitoring application such as a thermometer (i.e.. temperature sensor); it fetches data for us to operate on.
- Sensors could be analog or digital.
- 1. Camera used in home security systems.
- 2. Weather tracking system uses temperature/humidity/moisture sensors.
- 3. Vehicle health monitoring sensors keep track of speed, tyre pressure, etc.
- 4. On Board Diagnostics (OBDs) such as ELM327 are used for collecting all critical information from an automobile to detect anomalies.
- 5. Vibration sensors are used to track the quality of buildings/structures.
- 6. Water quality is monitored through sensors that measure PH, turbidity, chloride level, etc.
- 7. PIR sensor is used to detect human presence.

- 1.2 Cloud Computing
- The next technology that is highly significant in IoT is cloud computing.
- Data storage plays a major role in IoT.
- As a data storage option, cloud has grown much more popular than expected because it serves as an affordable, effective and efficient medium for data storage.

Figure 1.17 Sensors that act as enabling technologies

Cloud services are categorized as follows:

- 1.IaaS (Infrastructure-as-a-Service):
- In this cloud service, one can choose virtual machines over physical machines.
- In other words, it is a form of cloud computing that provides virtualized computing resources over the Internet.
- The users manage the machines, select the OS and underlying applications, and pay per their use.
- 2. PaaS (Platform-as-a-Service):
- This is a cloud computing model in which the cloud service provider (a third-party provider) delivers hardware and software tools needed for application development to users over the Internet.
- A PaaS provider hosts the hardware and software on its own infrastructure.
- Users have to build, manage and maintain the applications as per their requirement.
- 3. SaaS (Software-as-a-Service):
- In this model, a complete software application is provided to the user.
- It can also be called application as a service.
- This service can be availed by paying a monthly, yearly, etc., subscription.
- Some well-known service providers in the market are Amazon web services, Azure and Adafruit.


SaaS
Software as a Service
Email
CRM
Collaborative
ERP
CONSUME IT
PaaS
Platform as a Service
App Dev
Decision Support
Web
Streaming
BUILD ON IT
IaaS
Infrastructure as a Service
Caching
Networking
Security
System Mgmt
MIGRATE TO IT

- 1.3 Big Data Analytics
- Data is everywhere, and from every function or operation we get more data.
- IoT is all about collecting data from various sensory nodes and handling the huge data is fundamental to make the application a success,
- The biggest challenge with big data is its volume, variety, speed (velocity) at which it comes and its veracity.
- These are fondly referred as the 4Vs of big data.
- Big data is majorly governed by the following:
- 1. Scale (Volume):
- Huge volume of data is generated every minute.
- Storage has become inexpensive and hence, cost-related challenges have reduced.
- Cloud storage and hardware storage both have become affordable because of the tremendous growth in the semiconductor industry.
- 2. Complexity (Variety):
- Data no longer comes from one single source.
- Moreover, it comes in different formats (e.g. audio, video, text and image) and has to be interpreted systematically.
- This becomes a huge challenge.

- 3. Speed (Velocity):
- It is the rate at which new data is being created.
- The rate at which data is generated is very fast.
- Also, data dynamics changes very frequently.
- Nowadays, data can come from anywhere from fitbit watches to refrigerators.
- All the data pours in at a very high speed, which makes it very challenging to not miss and oversee the actual data from the noise.

- 1.4. Data in doubt (Veracity):
- It is perhaps the one hidden secret of all the data we now rely on.
- How accurate is all this data anyway?
- The data's nature alters dynamically and ambiguity is often seen (incomplete data).
- Hence, it would be pretty challenging to process this unstable data.

- So the question is: "Who is generating all this data?"
- 1. Sensors from security systems.
- 2. Sensors from weather monitoring systems.
- 3. Sensors from car/navigation systems.
- 4. Sensors from water quality monitoring systems
- 5. Data from wearables (e.g. bands).
- 6. Data from industrial equipment (eg, motor health).
- 7. Sensors from bridges/roads about traffic density and other factors.
- 8. Social media (e.g., tweets, photo uploads, etc.).
- When it comes to IoT, it is all about data, which is everything. Hence, data analytics is one of the enabling technologies for building a complete and comprehensive IoT application.

- 1.5 Embedded Computing Boards
- An embedded computing board a very important component to bring IoT design to reality.
- From the proof of concept to the prototype, all these are linked with the computing boards.
- Most of the computing boards available in the market are driven by microcontrollers or processors.
- Some of the boards are as follows:
- 1. Raspberry Pi.
- 2. Arduino (many variants).
- 3. NodeMCU.
- 4. Intel Edison.
- 5. Intel UP Squared" Grove IoT Development Kit.
- All these boards are small, yet smart. Also, the cost involved is very minimal and one can get these boards for less than a hundred dollars.
- Figure 1.18 shows some of these boards.

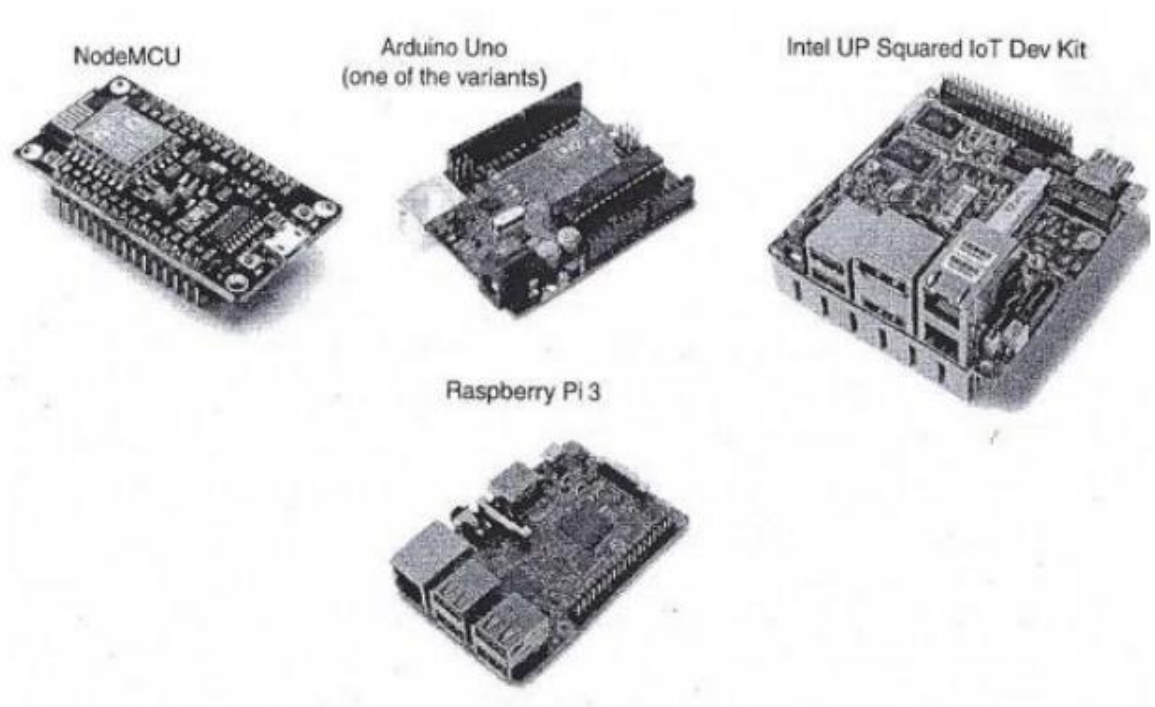


Figure 1.18 Computing boards

- 1.6Communication Protocols
- Protocols are the pillars for good IoT infrastructure and hence are very important in communication.
- Data exchange happens through these protocols, which take care of the following:

1. Addressing.
2. Format of the messages.
3. Message security (encryption and decryption).
4. Routing.
5. Flow control.
6. Error monitoring.
7. Sequencing.
8. Retransmission guidelines.
9. Segmentation of the data packets

- 1.7 User Interfaces
- All devices must have a good and pleasant user interface.
- IoT devices/services should be designed in such a way that accessing and handling the services are easier and comfortable for the end user.
- In most cases, the end user shall be provided with "mobile application or web application".
- The application should be consistent and not clumsy.

Thank You